FUSIFORM BACILLI ASSOCIATED WITH VARIOUS PATHOLOGICAL PROCESSES.*

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The occurrence of fusiform bacilli in connection with ulcero-membranous anginas, ulcerative stomatitis, and noma is well known. The impression is obtained from the literature that these organisms are rarely found in morbid processes in other parts of the body.

In 1909, Ghon and Mucha[1] reported two cases of brain abscesses in which they found organisms of this type as the only demonstrable causes. Attempts at cultivation were unsuccessful. These abscesses were a part of a general pyemic process. In one case the primary infection was believed to be in the appendix; in the other case in a bronchiectatic abscess. In 1910, Kaspar and Kern[2] reported two more cases of pyemia in which fusiform bacilli were found and in one of these cases the bacilli were isolated in pure culture. In these cases the generalized infection followed appendicitis in one and a lung abscess in the other. In 1911, Peters[3] reported the finding of fusiform bacilli in smears in a case of lung abscess, in a case of fetid bronchitis, and in a case of hand infection. From a second case of hand infection, the bacilli were isolated in pure culture. In both hand infections, the wounds were caused by the teeth of other persons.

In 1911, Heyde,[4] in an examination of 102 cases of appendicitis, found fusiform bacilli in eight cases. In 1912, Rosenow and Tunnicliff[5] reported a case of pyemia in which pure cultures of fusiform bacilli were isolated from various lesions in the body. This case followed appendicitis with abscess formation.

It will be seen that the primary infections in all of these cases,

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[1] *Centralbl. f. Bakt.*, I, Orig., 1909, 49, p. 493.

[2] *Ibid.*, 1910, 55, p. 97.

[3] *Jour. Infect. Dis.*, 1911, 8, p. 455.

[4] *Ztschr. f. klin. Chir.*, 1911, 76, p. 1.

[5] *Jour. Infect. Dis.*, 1912, 10, p. 1.

excepting the infection of the hands from teeth, were either in the appendix or in the lung.

The following seven cases were examined postmortem by Dr. E. R. LeCount, to whom I am indebted for the opportunity to make the bacteriological examinations.

Case 1.—A man, 35 years old, was perfectly well up to five days before death. At that time he was taken with a severe headache which persisted. He vomited several times and had several chills. Was in the hospital about 24 hours, during which time the temperature ranged about 101°, pulse 80, leukocytes 25,000.

The anatomical diagnosis: Purulent and putrid meningitis, thrombophlebitis of left lateral sinus with necrosis of the temporal bone; chronic otitis media of left ear, acute follicular tonsilitis, hydropericardium, fibrous adhesive pericholicystitis, healed myocarditis.

The following is a description of the cranial cavity: The petrous bone on the left side contains a clot with a grayish-green color. There is necrotic tissue and pus in the middle ear. The right ear is unaltered. On removing the falx cerebri, there is a thick pus which flows out from the posterior part of the inferior longitudinal sinus. This is considerable in amount and foul-smelling. On the under surface of the cerebellum is a gray-green exudate which entirely obliterates the cerebellum. The posterior folds of the cerebrum are furrowed from the tentorium and pressure that existed under the tentorium and in the posterior part of the skull. The exudate is not marked about the circle of Willis but is apparent at the junction of the pons and medulla and at the vertex of the cerebrum. The convolutions are flattened. The sulci are not rounded but form right angles. The weight of the brain was 1,460 gms.

Bacteriological examinations: In stained smears of the purulent cerebrospinal fluid, many small gram-positive cocci in short chains and pairs were found. Slender gram-negative bacilli of lengths varying from a few microns to long, threadlike organisms were the only other organisms present.

Cultures were made on horse serum agar slants, made anaerobic by Wright's method, and in serum broth in an atmosphere of hydrogen. In the cultures on serum agar, the streptococcus alone

grew. It was a small gram-positive organism, the colonies of which resembled the streptococcus viridans. It grew more readily anaerobically than aerobically, and formed almost no green on blood agar. In the hydrogen serum broth cultures, bacilli resembling those of the smears were found. The long, threadlike forms predominated. From this serum broth culture, plates were made and incubated in jars from which the air was exhausted and the remaining oxygen removed as far as possible with pyrogallic acid and sodium hydrate. On these plates, several colonies of the bacilli developed in four days. These colonies were about two millimeters in diameter, flat, sharp in outline, and of a pearly translucent appearance. The bacilli in these colonies did not form such long filaments as in the broth cultures, were vacuolated, and in some instances swollen and irregular in size and shape. Attempts at subculture from these colonies failed. Various attempts were made to produce lesions in animals with the mixed cultures. Guinea-pigs were inoculated intracardially and the meninges and brain at the same time traumatized by perforating the skull with a stout needle. Rabbits were injected subcutaneously into the liver. A monkey was injected subcutaneously. In no instance was any pathogenic power for animals demonstrated.

Case 2.—This was a case in which no history was obtainable.

The following is the anatomical diagnosis: Fibrous adhesions between the left lung and chest wall, bronchiectasis of left lower lobe of lung, abscess in left occipital lobe of brain, fibrino-purulent basilar meningitis, hyperplasia of the spleen, cloudy swelling of liver, pancreas, and spleen, chronic interstitial nephritis, slight fibrous myocarditis with sclerosis of coronary arteries, marked emphysema of right lung and left upper lobe, passive hyperemia of liver, patent foramen ovale, fibrous epicardial patches, chronic mitral endocarditis.

The smears from the meningeal pus contained two kinds of organisms, a gram-positive lanceolate diplococcus and many long, threadlike organisms which did not retain the gram stain. Cultures were made on blood agar slants kept anaerobic by Wright's method and colonies of both the diplococcus and the gram-negative bacilli isolated. The diplococcus was identified as the pneumo-

coccus. The bacillus was found to contain a few coccus forms and dilutions were made in broth and the surface of blood agar slants seeded with these dilutions. In this way the bacillus, which formed long filaments on the surface of the blood agar slants, was isolated in pure culture. It grew only on serum ascites on blood media. The blood was not affected. It formed semi-translucent colonies easily removed from the surface of the agar. These colonies were hard to break up in liquids. Ascites gelatin was not liquefied. The growth appeared as a light opacity along the stab with no tendency to diffuse through the gelatin.

The organisms from the surface of slants were mostly slender spindle-shaped rods with many slightly longer curved forms and here and there long threads. Many beaded forms were seen.

The organism in pure culture was non-pathogenic for guinea-pigs. A large quantity of a mixed culture injected in a dog intravenously caused death apparently from intoxication from the pneumococcus present.

Case 3.—A man, 48 years of age, was admitted to the hospital complaining of severe headache. He had vomited a number of times, had been severely sick for two weeks, and had had a chronic bronchitis. The physical examination was negative except for deafness and bubbling rales over both lungs. The patient had two generalized convulsions of a clonic type and died a few hours after admission to the hospital.

The anatomical diagnosis at autopsy was: Cerebellar abscess, diffuse purulent leptomeningitis, sclerosis of the coronary arteries, fibrous myocarditis, bilateral catarrhal bronchitis, fibrous miliary tuberculosis of both pleurae, emphysema of both lungs, chronic catarrhal gastritis.

A description of the brain follows: On the middle of the under surface of the right lobe of the cerebellum there is an area of softening as large as a silver dollar. There is a foul-smelling, grayish-green pus exuding from this region. The convolutions of the brain are flattened and there is a slight amount of a grayish exudate in the meshes of the pia arachnoid. All of the minute vessels of the pia are engorged with blood. The fluid in the lateral ventricles is blood-stained. Numerous sections through all por-

tions of the cerebrum fail to reveal other gross lesions. Examinations of the sinuses, jugular veins, and middle ears and Eustachian tubes fail to reveal any gross changes. There is a thickening of the Eustachian tube on the right side. On a section of the cerebellum there is revealed an abscess cavity (4×2 cm.) occupying most of the right cerebellar lobe. It is filled with grayish-green, foul-smelling pus and surrounded by a grayish infiltration.

Bacteriological examination: In smears from the meningeal exudate two types of organisms. Small cocci, weakly gram-positive or gram-negative, in some instances were present in moderate numbers and great numbers of slender gram-negative bacilli for the most part about the length of the diameter of a pus cell or less. Many slightly longer forms were found. In many places large groups of these bacilli, as in colonies, were found. In the cultures, the streptococcus viridans and fusiform bacilli were isolated in mixed culture.

The fusiform bacilli grew well on blood agar slants but colonies free from cocci were not obtained. Mixed cultures injected intracardially in guinea-pigs in which the brain had been traumatized produced no lesions. The bacilli in the mixed cultures resembled in morphology those of cases 1 and 2.

Case 4.—A man, 43 years of age, fell and fractured the eighth and ninth ribs on the left side. Eleven months later he developed delirium tremens and bronchopneumonia. From that time until his death, three weeks later, he coughed up large quantities of mucopurulent material.

The anatomical diagnosis: Healing fractures of the eighth and ninth ribs, subpleural traumatic hemorrhages about the broken ribs, subparietal gangrene of left lung, pneumonia of both lungs, purulent and putrid serofibrinous pleuritis, compression atelectasis of the left lower lobe, emaciation, acute tracheobronchial lymphadenitis, diverticulum of the esophagus.

Smears from the pus show various gram-negative and -positive bacilli and cocci. There are many gram-negative slender pointed bacilli of all lengths up to threadlike filaments. From the cultures were isolated the staphylococcus albus and aureus, a pseudodiphtheria bacillus, a Friedlander bacillus, and a small gram-negative

bacillus similar to the colon bacillus. This bacillus grew only upon serum media anaerobically. It formed in four to five days an abundance of coal-black pigment.

In addition to these organisms, a fusiform bacillus was isolated in pure culture. The organism did not differ from the others described and the growth from six blood agar slants produced no lesions when injected into the testicle of a rabbit. Associated with the fusiform bacilli in the first subcultures was a streptococcus which occurred in short chains and pairs. It retained the Gram stain, grew better anaerobically than aerobically, did not affect blood and milk, did not ferment lactose, dextrose, mannite, or inulin.

Case 5.—The patient was a middle-aged man who died a few hours after admission to the hospital.

The anatomical diagnosis was as follows: Resolving pneumonia of the right upper lobe of the lung, unresolved pneumonia of the right lower lobe with multiple abscesses and gangrene, edema and hyperplasia of the tracheobronchial lymph glands, right-sided serofibrinous pleuritis, hemothorax from erosions of the lung produced by gangrene, partial compression atelectasis of the right lung, multiple miliary gummata of the capsule of the liver, hyperplasia of the lower esophageal lymph glands, cerebral softening, healing and healed luetic caries of the skull bones, marked sclerosis and calcification of the coronary arteries, slight fibrous myocarditis.

Bacteriological examination: The gram preparation of the pus itself showed large numbers of gram-negative fusiform bacilli of various lengths, many slightly wavy gram-negative spirilla, and some gram-positive streptococci. In pure cultures there were isolated the following organisms: *Streptococcus pyogenes*, a gram-negative slender bacillus with a marked tendency to pleomorphism growing only on blood media. It forms on blood agar slants growths in 24 hours which are slightly opaque and in four to six days become pigmented until jet black. *Fusiform bacilli.* This strain of fusiform bacilli did not differ from the ones from the other cases in morphology but grew on ordinary media to some extent. It did not affect milk, did not ferment lactose, glucose, inulin, or mannite. In lactose media, it tended to form longer filaments than on blood, was thicker, more vacuolated, and granular.

It was non-pathogenic for dogs when injected into the vein of a dog in large numbers. The spiral forms were not obtained in culture unless they are to be regarded as by Tunnicliff[1] and others as forms of fusiform bacilli. Some of the forms on lactose agar resembling the wavy forms found in the smear are suggestive of this view.

Case 6.—The patient was a man who died a few hours after entering the hospital. A huge foul-smelling empyema was found. The bacteriological examination showed the staphylococcus pyogenes albus, and fusiform bacilli. The bacilli did not differ from those described. The pathogenicity was not tested.

Case 7.—The patient died of a peritonitis following an abortion.

The following anatomical diagnosis was made: Corpus luteum of left ovary, parturient uterus, acute endometritis, erosion of the cervix, serofibrino-purulent peritonitis, marked cloudy swelling and fatty changes in the kidneys, cloudy swelling and fatty infiltration of the myocardium, cloudy swelling of the liver, petechial hemorrhages in the skin of the arms and right thigh, hyperplasia of the spleen, hyperplasia of the mesenteric lymph glands, recent laparotomy wound, old healed and incapsulated tuberculosis of the right apex, left fibrous pleuritis, anthracosis of the lung.

Bacteriological examination: The smears from the peritoneal exudate showed many gram-negative spindle-shaped bacilli, gram-positive bacilli, and streptococci. The following organisms were isolated in pure culture: *B. fusiformis*, *B. welchii*, *Streptococcus pyogenes*, a slender gram-negative bacillus which corresponded to the pigment-forming bacillus in case 4.

SUMMARY.

Fusiform bacilli were found in three cases of meningitis. In one of these cases, the infection probably arose from the middle ear which is in communication with the nasopharynx in which fusiform bacilli are commonly found. In the other two cases the infection probably followed chronic bronchitis, as in the cases reported by Ghon and Mucha and by Kaspar and Kern. Three cases of lung infection associated with fusiform bacilli are described, the first a bronchiectasis, the second a gangrene, and the third an empyema.

[1] *Jour. Infect Dis.*, 1906, 3, p. 148.

Fusiform bacilli were found in a case of peritonitis following an endometritis. The importance of the fusiform bacilli in causing the pathological processes with which they were associated, must remain an open question. The negative results of all attempts to demonstrate pathogenic powers for animals suggest that the organism may have been present only as a secondary invader, as other organisms were found in all the cases.